University of Gdańsk

Subject card

Subject name and code	Signatures of non-classicality, PG_00158049		
Field of study	Quantum Information Technology		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
Education level	Master's studies	Subject group	Obligatory subject group in the field of study
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	English
Semester of study	2	ECTS credits	6.0
Learning profile	academic	Assessment form	exam
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	dr Beata Zjawin	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	30.0	0.0	0.0	0.0	60

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	60	0.0	30.0	90

Subject objectives

Get acquainted with the concept of nonclassical phenomena as a fundamental property of Nature.Learn about the traditional phenomena of Entanglement and Bell nonclassicality, the recently reformulated notions of Steering and Kochen-Specker contextuality, and the newly identified phenomena of Spekkens contextuality and Network nonclassicality.Understand not only the foundational implications of these nonclassical phenomena, but also their role as resources for information processing.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[QITL3_W04] knows advanced methods of theoretical and mathematical physics necessary in creating models of quantum mechanics	Student has a clear understanding of models of classicality and how Nature does not respect them. Student knows and understands the basic concepts and terminology used in the quantum foundations approach to quantum information. Student knows the proofs of the main facts such as Asymptotic Equipartition Property, Shanonn's theorem etc., as well as knows basic methods such as compression algorithms	[SW4] test/exam - oral or written

Subject contents	Entanglement theory: bipartite and multipartite entanglement; separability criteria; entanglement distillation and monogamy; applications (e.g.,teleportation).Bell nonclassicality: Bells theorem; Fines theorem; Bell inequalities; Entanglement vs. Bell nonclassicality; bipartite and multipartite Bell scenarios;activation of Bell nonclassicality; the geometry of correlations (No-Signalling and Classical polytopes, the quantum set); applications.Contextuality: Kochen-Specker contextuality; state dependent vs. state independent contextuality; inequalities from hypergraphs; Spekkenscontextuality; applications.Steering: bipartite and multipartite steering; steering inequalities; applications.Network nonclassicality: brief introduction to networks, examples, and applications
Prerequisites and co-requisites	None.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
tutorial part: test	51.0%	50.0%
lecture part: exam	51.0%	50.0%

Recommended reading	Basic literature	R. Horodecki, P. Horodecki, M. Horodecki, and K. Horodecki. Quantum entanglement, Rev. Mod. Phys. 81, 865 (2009).N. Brunner, D. Cavalcanti, S. Pironio, V. Scarani, and S. Wehner. Bell nonlocality, Rev. Mod. Phys. 86, 419 (2014).D. Cavalcanti and P. Skrzypczyk. Quantum steering: a review with focus on semidefinite programming, Rep. Prog. Phys. 80, 024001 (2017).A. Cabello, S. Severini, and A, Winter. (Non-)Contextuality of Physical Theories as an Axiom, arXiv: 1010.2163 (2010).A. Acín, T. Fritz, A. Leverrier, and A. B. Sainz. A Combinatorial Approach to Nonlocality and Contextuality, Comm. Math. Phys. 334, 533 (2015).R. W. Spekkens. Contextuality for preparations, transformations, and unsharp measurements, Phys. Rev. A 71, 052108 (2005).C. Branciard, D. Rosset, N. Gisin, and S. Pironio. Bilocal versus non-bilocal correlations in entanglement swapping experiments, Phys. Rev. A 85,032119 (2012).T. Van Himbeeck, et al. Quantum violations in the Instrumental scenario and their relations to the Bell scenario, Quantum 3, 186 (2019).
	Supplementary literature	None.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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